said second cooperating magnet force generating means being fixed relative to each other on said platform, said first force applying means being positioned and constructed to controllably apply selected forces to said platform in one of said two different directions and said second force applying means being constructed and positioned to controllably apply selected forces to said platform in the other of said two different directions and control means to selectively control said first and said second force applying means to generate said selected forces.

a1 cancld

Remarks

Claims 1 to 18 inclusive remain in the application.

By this amendment, the reference to the micro-controller 67 as being shown in Figure 3 has been corrected by referring to Figure 1 in which the micro-controller 67 is shown. It is believed this amendment overcomes the objection raised in paragraph 1 of the Office Action and that there is no need to submit drawing corrections as proposed in paragraph 2.

Claim 1 has been revised to make it perfectly clear that the first and second magnet means are in relatively fixed relationship on the base as are the first and second cooperating magnetic force generating means on the platform.

Reconsideration of the rejection of all of the claims of this application with the exception of claims 16 to 18 inclusive in view of cited art particularly, in view of Purcell and Cadoz et al. is respectively requested.

It is clear that Purcell does describe a drafting device having a base 10 on which is mounted a platform 30 which can move in both the X and Y directions. Purcell also provides a sensor for determining the X and Y coordinates.

It is also clear that Cadoz et al. teaches the use of magnets and cooperating magnets for force generating. It is also true that Cadoz refers to the use of the force applying means in a two a degree of freedom joystick. There is however, no disclosure or even remote suggestion in Cadoz et al. of providing a second magnetic force applying means arranged in a manner taught by Applicant to obtain selected forces in two mutually perpendicular directions. Cadoz et al. has taught the use of pair of magnetic force generating devices, i.e. magnet means and cooperating magnetic means in a specific arrangement which is shown in Figure 9 of Cadoz et al., but this does not attain

applicant's results nor is it capable of attaining applicant's desired results without a complete restructuring. Any such restructuring would have to be based on applicant's teachings not those found in any of the references cited as they do not lead toward applicant's structure.

It seems to be a long step from the teachings of either of the references taken alone or combined to select the magnetic force applying means of Cadoz et al., modify it to meet applicant's requirements and then apply it to Purcell in the specific manner required to construct the invention defined in Applicant's claim. Such a reconstruction, it is submitted, could only be arrived at by hindsight if one had applicant's teachings in hand.

Even if one were to modify Cadoz et al. and then attempt combine this teaching with the passive system of Purcell in what might appear to be a logical manner, it is submitted, the most likely structure that could be generated based on any such combination and using conventional thinking would be a system wherein each of the axes of Purcell is individually motorized using a flat magnetic actuator similar to what is taught in Cadoz et al. This approach of simply combining the magnetic actuators of Cadoz et al. with passive system of Purcell produces an arrangement wherein the first actuator is mounted between the base 10 and the carriage 20 of Purcell to provide a first magnetic force and then a second actuator is positioned between the carriage 20 and the platform or gantry 30 to provide a second magnetic force. This requires that the first motorized axis (20) carry the actuator for the second motorized axis (30). Compare this with Applicant's invention as defined in claim 1 and it is apparent that such a structure would not provide the structure defined in claim 1 in that one of the key elements of the present invention, namely carrying both the cooperating magnet means on one element (the platform) and mounting both the magnet means on a second element (the base). Claim 1 specifies

a "a first magnet means mounted on said base"

b. "a first cooperating magnetic force generating means mounted on and moveable with said platform"

c "a second magnet means mounted on said base"

d. " a second cooperating magnetic force generating means mounted on and moveable with said platform"

e. "said first and said second magnet means being fixed relative to each other on said base and said first and said second cooperating magnet force generating means being fixed relative to each other on said platform"

The structure defined thus clearly requires that both the magnet means (first and second) be mounted in fixed relationship on the base and both the cooperating magnet means (first and second) be mounted in fixed relationship on and moveable with the platform.

It is apparent that the system described by Applicant and defined in Applicant's claims wherein both the first and second magnetic forces are generated and applied directly between the base and the moveable platform is a significant improvement not obvious from the prior art. This construction considerably reduces the mass that the first actuator must move to allow a very light guides for the platform which permits more accurate operation.

The structure claimed by Applicant is not easily applied to the Purcell system and certainly it is not obvious to apply Applicant's invention based on the teachings of Purcell and Cadoz et al.

Even though Cadoz et al. does suggest use of light magnetic actuators to emulate a two degrees of freedom joystick, his proposed mechanism contains no less than five moving parts which include two friction drives and three conventional bearings plus the coil guides.

In Applicant's system as above indicated, the coils are mounted on a single moving part namely on a platform.

It is not believed that further discussion of the Purcell and Cadoz et al. reference is warranted since there are very clear distinctions between the present invention and the combined teachings of these two references.

Other claims, namely, claims 4 and 6 rejected further in view of Yuasa on the basis that Yuasa teaches sensor means which comprises a transparent grid and a light source together with a detector.

The particular sensor used is not as important in the present invention as is the particular manner in which the elements of the sensor are mounted so that the movement of the moving part relative to the base is measured directly thereby to eliminate errors due to mechanical alignments, bending, backlash, etc. In this respect,

the sensor taught by Yuasa, even though it provides two active axes, the sensor is quite inappropriate for force feedback control since there are intermediate moving elements the sphere 4 and rollers 6 in Figure 1 of Yuasa) that compound the errors and add mass.

The sensing scheme taught by Purcell uses two linear sensors, one for each axis. Bending or misalignment of the second axis compounds the error in the first sensor thus, leading to inaccurate sensing of the controller pointer. Thus the arrangement of Purcell is not as effective as the system as claimed by Applicant.

Those skilled in the art of robotics and teleoperating will recognize that one of the more important design goals for a controller with force feedback is accurate high high bandwidth position and force control. For this to occur, it is believed, that the actuation and sensing of motion device be co-located. However, the design of such mechanism has proved to be very challenging.

The present invention as applied to a two-axis planar motion device can be applied as a force feedback controller because

a. it has low moving mass
b. it's preferred arrangement has no mechanical force or position transmission elements
c. the actuation and sensing elements are co-located i.e. on the same rigid body

None of which found in the prior art or the combination of prior art as suggested by the Examiner.

As a matter of interest, the prototype of the present invention has been controlled in closed-loop to a position frequency response and excess of 100 hertz (the force feed consider a response exceeds 500 hertz).

As pointed out above, there are clear lines of demarcation between the claimed invention particularly the broad claim 1 and the art cited whether taken singly or in combination. It is therefore submitted that this application is in condition for allowance and such action is respectfully requested.

Respectfully submitted,

C.A. Rowley 20,781
Agent for Applicant
Date: July 26, 1993
Telephone: (604) 439-8654